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An Attempt to Appraise the Standing of Biology as a Subject of Instruction in High School

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An Attempt to Appraise the Standing of Biology as a Subject of
Instruction in High School.

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INTRODUCTION

A subject may hold a place in the curriculum of our secondary schools in one of two ways. First, it may have its position traditionally, as does mathematics or Latin; second, it may have been given its present rank in response to a popular demand for the knowledge content, training value, or esthetic worth it possesses. The latter has been the case with what we may call our "modern" subjects, especially some of the social and natural sciences. Of the natural sciences, biology is of comparatively recent development, being in a sense the outgrowth of the older sciences, botany, zoology, and physiology. Moreover, in answer to the variable needs of our changing high-school population and in an endeavor to meet the ever-increasing demands made on our schools to fit that population for the numerous and exacting activities of modern civilization, biology had been gradually replacing the older sciences and bids fair to do so permanently.

But whether the present status of biology is due to its knowledge content, its training value, or its esthetic worth it is not my purpose to discuss. Since it has acquired a recognized standing, there appears a more interesting problem which invites study with the possibility of bringing worth-while results. Considering that our older subjects--those traditionally in the curriculum--have been tried and tested and measured, holding their place only in so far as they are found to possess real value, we can easily see that the same requirement will be imposed upon the newer ones, and that they will have to prove their utility or give place to other, newer, and, for the time being, more interesting "groups of facts".

Does biology justify its standing in the secondary-school curriculum? Is its education value on a par with that of other subjects? The problem may be approached from various points of view, but any solution requires careful consideration of the opinions of persons who are qualified to judge such matters.

Among those whose experience would make them of service to us in this connection we may class: (1) students who, having taken the course in high school or college, have had a chance to try out its value in their lives; (2) biology teachers who have studied the reactions and watched the development of their pupils; (3) nurses who have made practical use of the knowledge and the training of their biology course; (4) and finally doctors who have had a chance to see the need for knowledge of biological facts among the people at large. Hence, the purpose of this thesis is to attempt a survey of the opinions of students, teachers, nurses, and doctors concerning the educational value of biology as a secondary-school subject.

But before we are prepared to decide on the educational values that may be attributed to biology, it seems fitting to see what we mean by education, what it is to do for us, in other words, what are the general aims and values which current educational theory holds as desirable. That is to say, a preliminary discussion of the meaning of education, of its general aims, purposes, and values will be necessary for a clear understanding of our problem.

EDUCATION DEFINED

A statement of the meaning of education may be secured by analysis of the definitions left us by great men of all ages. Loyola Educational Digest in June, 1924, published a list of thirty-nine such definitions beginning with Aristotle's and Plato's and concluding with Bagley's and Parker's (53:67-68). James Higgins in his "Fundamentals of Pedagogy" quotes thirteen, (29:7) and John Franklin Brown uses eight as a foundation on which he bases his book (10:91). Since four of the above-mentioned numbers were quoted twice, there remains a total of fifty-six from which the conclusions are drawn.

The key word is by common agreement, preparation, process, development or training. The object to which the changes implied in the key word are to be applied is universally designated as the faculties of the human being. These faculties, mentioned by some, are in the more complete definitions given as: mental, spiritual, physical, and moral. Lastly, the greater number of these definitions include an indication of the end or purpose of the desired change, and this is usually proposed as the aim of education. In fact, this third part seems to be of such importance that several of the statements consist solely of the aim. Besides the definitions already discussed there are several so broad that they cannot easily be classified as above. Such are those of Comenius, Davidson, Milton, Montaigne, and some others (53:67-68).

Hence we may agree with J. F. Brown, that "the end of education is complex rather than simple. Any statement of it in a single phrase is likely to be too general and abstract to be of much worth as a test of

educational values" (10:95).

One of the most complete statements of the meaning of education is that given by Rev. James Higgins, who says: "Education is the harmonious development of the physical, the mental, the aesthetic, and the religious powers of man to prepare him for right living in this world that he may attain the end for which he was created" (29:7).

THE ULTIMATE AIM

This statement of aim includes both the ultimate and the proximate aim and is broad enough to cover all the subdivisions commonly set forth in each category. The ultimate aim, "that he may attain the end for which he was created", is the final purpose of education and as such must satisfy every kind of educational theory. We, the advocates of Christian education, hold to the belief that man's work here on earth is but a preparation for his future life in heaven.

This ultimate aim may be conceded to be what the Commission on the Reorganization of Education had in mind when they thus defined education: "Education in a democracy, both within and without the school, should develop in each individual the knowledge, interests, ideals, habits, and powers whereby he will find his place and use that place to shape both himself and society towards ever nobler ends" (61:9). In this case "ever nobler ends" would be interpreted to mean "the end for which he was created".

Comprehensive as is this statement of the end of education, its influence on secondary educational policy consisted in the fact that it was proposed by such a representative body as the National Educational Association. Subsequent writers have adopted it when they considered a mention of aim necessary. Some, however, have adopted it in part only. Thus Bolton says: "The chief objective of secondary school education should be the development of the highest type of citizenship" (9:273). Yet in advocating citizenship as the chief objective, Bolton corroborated the de-

claration of the Commission: "It is the ideal of democracy that the individual and society may find fulfillment in each other" (61:9). That is to say, in the proper discharge of his duties as a citizen the individual finds his fullest personal development.

The aim which we have selected lays a broader basis for an educational policy than the "social efficiency" selected by Bagley (3:54) as a norm to which he applies his discussion of values.

Such, also, is the point of view taken by Stout: "The use of the term social efficiency is peculiarly appropriate in defining the aim of secondary education. The adolescent period is one in which socialization takes place in the largest measure" (59:18).

Butler, however, advocates a broader point of view: "If education cannot be identified with mere instruction, what is it? I answer, it must mean a gradual adjustment to the spiritual possessions of the race, with the view to realizing one's own potentialities and to assisting in carrying forward that complex of ideas, acts, and institutions which we call civilization" (13:25-26).

The idea of adjustment as an educative purpose is implied in the writings of Shields: "It is the purpose of education, in the widest acceptance of that term, to substitute for instinct the control of intellect and free will so as to secure action in conformity to the laws of nature and the dictates of the divine will" (56:176).

The above are considered modern conceptions of the aim of education. Yet, in 1896, Baker states his view: "We estimate a man's worth by his intellectual grasp, his aesthetic and ethical insight, and his power for action towards good and useful ends. If these characteristics made the

ideal man, they should be the ideal aim of education, and a study is to be valued as it best contributes to developing them" (5:197).

Again in a treatise on "Moral Education" published in 1879, we find: "The aim of education is to combine the cultivation of the intellect with the formation of the moral, and the direction of the spiritual life so that each faculty of body, mind, and soul shall be in the highest degree trained and fitted to fulfill the purpose for which God endowed us with it" (14:9).

Even more complete is the aim developed for the teachers of his time by the great French educator, Mgr. Dupanloup, in 1850: "Education is the complete development of man according to the plan outlined by Providence. This work is accomplished by development of the physical, intellectual, moral and religious faculties of the child; it thus becomes for him a preparation, remote but essential, for all the duties he will later have to fulfill during his life on earth" (21:254).

PROXIMATE AIMS

Right living in this world is the proximate aim. All other aims that stop short of it are incomplete. For instance, efficiency that does not apply to right living may be a very undesirable thing. A burglar is unusually very efficient in his trade but he is not "living rightly." So also, service, or knowledge, or power, or skill, if not subordinated to right living may lead to evil. Hence, they cannot be considered as ends in themselves.

However, right living as a proximate aim is very broad and to be of use to the educator must be simplified somewhat. The endeavor to thus simplify the aim of education has resulted in the formation of several lists of objectives which the authors mentioned above propose as the proximate aims of education. The Commission already quoted gives seven: .
"1. Health, 2. Command of Fundamental Processes, 3. Worthy Home-membership, 4. Vocation, 5. Citizenship, 6. Worthy Use of Leisure, 7. Ethical Character" (61:10-11). Moreover, the Commission judges that every high-school subject should contribute as much as possible towards these objectives. "Each subject now taught in high schools is in need of extensive reorganization in order that it may contribute more effectively to the objectives outlined herein, and the place of that subject in secondary education should depend upon the value of such contribution" (61:16).

Dr. Shields, having discussed at some length the ultimate aim of Christian education, says: "While accepting the ultimate aim of education as herein set forth, it is necessary, in order to attain efficiency in his work, that the teacher should attempt to formulate for himself a

series of concrete and definite secondary aims which in their turn may be regarded as means to the attainment of the ultimate aim which should give final direction to all his efforts" (56:180). He then gives five secondary aims: (1) physical efficiency, (2) economic efficiency, (3) social efficiency, (4) individual culture, (5) citizenship.

John Franklin Brown declares: "In more definite and concrete terms this end may be said to include physical health and efficiency, manual skill, a large amount of information concerning man and his nature, trained intellectual powers, an appreciation of the good, the true and the beautiful, and an attitude of personal devotion to them, broad sympathies and a desire and purpose to live the fullest possible human life, both as an individual and as a member of society. In proportion to the degree in which a study contributes to these ends it may be said to have educational value" (10:95).

Butler adds to his statement of the ultimate aim: "Those spiritual possessions may be variously classified, but they certainly are at least five-fold. The child is entitled to his scientific inheritance, to his literary inheritance, to his aesthetic inheritance, to his institutional inheritance, and to his religious inheritance. Without them all he cannot be truly educated" (13:26).

Bagley develops his "social efficiency" aim by giving the characteristics of the socially efficient individual. "(1) economically efficient, or ability to "pull his own weight" in economic life; (2) negative morality, or the willingness to sacrifice his own desires when their gratification would interfere with the economic efficiency of others; (3) positive morality, or the willingness to sacrifice his own desires when their grati-

fication would not interfere directly or indirectly to social progress" (3:107-08).

A comparison of these various sets of objectives shows that they are similar in content, and one can readily be expressed in terms of the other. Yet they may vary widely in their actual application. A recent study of educational objectives made by Carter V. Good proves that they do vary. The synopsis of this study given in the Loyola Educational Digest (53:754) shows that secondary education in twenty-six states and in the district of Columbia is based on one hundred and six different objectives. It is worthy of note, however, that those mentioned the greatest number of times are those recommended by the Commission (61:10-11). They occur in the following order: "(1) Vocational preparation, (2) Citizenship, (3) Health, (4) Worthy use of leisure, (5) Command of fundamental processes, (6) Worthy home membership, (7) Ethical character". Hence we may conclude that these objectives have been adopted rather widely; also that the interpretation of these objectives may have been modified to suit time, place, and circumstances. The variety of objectives, other than the seven mentioned, may indicate a healthy educational outlook of experimental analysis which will eventually show those that may be kept and those that will be discarded.

EDUCATIONAL VALUES

The Commission, as already quoted, states that the place of a subject in secondary education should depend upon the value of its contribution to these objectives. This brings us at once to the question of values. A search through the literature on the subject shows that educational values are variously classified. Millis holds that besides knowledge there are many other values that a subject may contribute. These he calls: (1) Instrumental, that is, "those contributions of a subject that serve as the tools or instruments which the individual employs in other activities" (43:28). This class he further divides into: "Preparatory and Introductory, Vocational, Ethical, Socializing, Conventional, and Health. (2) Cultural, that is, those contributing "to the development of those aspects of life which we comprise under the term of personality" (43:34). Three varieties of these values are given: Sentimental, Liberalizing, and Reconstructive. (3) Disciplinary, that is, "the reaction of studies on the mental processes, attitudes, and habits of pupils" (43:39). These values are then considered as: "Increase of Intellectual Power, Development of Mental Attitudes, and Formation of Valuable Habits".

Brown, in classifying educational values according to different points of view, as, practical information, intellectual power, character, social, and pupil's reaction says: "It will readily be seen that these different viewpoints are not mutually exclusive, but there is enough difference between them to warrant a separate consideration" (10:96).

Comparing the values offered by Brown with those of Millis we find the following:

1. Practical information is very wide in scope, yet it can hardly be said to correspond to Millis's instrumental values, for information is limited to knowledge, while the instrumental values include both knowledge and skills.

2. Intellectual power is but one of the three values which Millis calls disciplinary values.

3. Character may be roughly classed as a cultural value, but the social value is one mentioned by Millis as an instrumental value.

4. Brown adds the value from the point of view of the pupil's reaction, that is, the value to any particular individual at any particular time. Evidently such a point of view is out of place among general educational values. For this discussion must be confined to the intrinsic values of a subject. Particular values can best be determined by local authorities face to face with local conditions.

Bagley classifies values as: Utilitarian, preparatory, conventional, and socializing (3:120). Again comparing with those of Millis, we find:

1. Bagley thus describes what he considers as utilitarian values:

"Utilitarian values can be ascribed, therefore, only when the habits formed, or the knowledge imparted, or the ideals and prejudices engendered, can be shown to be essential to the solution of some economic situation which the pupil will in all probability face in after life" (3:120). Millis gives much the same definition for instrumental values. "By instrumental values is meant those contributions of a subject that serve as the tools or instruments which the individual employs in other activities. These values may arise from the kind of knowledge conveyed or from the species of skill developed in the study which may be employed in successfully performing the

functions of life or in coping with personal or social problems" (43:30).

2. In his subdivision of instrumental values Millis places the preparatory, conventional, and socializing. These are identical with the remaining values on Bagley's list. Moreover, in their explanation of the preparatory and conventional values both authors give similar meanings, even the same illustrations.

3. Bagley, since he adopts the "social efficiency aim", naturally goes into greater detail in explaining the socializing values. In so doing, however, he overlooks entirely anything that could correspond to Millis's remaining values, the cultural and the disciplinary.

From the above discussion we conclude that the chief values by which we may measure the contribution of any subject to the aims of education are the instrumental, the cultural, and the disciplinary. Let us now see to what degree biology possesses any or all of these values.

AIMS AND VALUES IN BIOLOGY

Any statement of the aims of biology in the secondary schools must be based on a study of the development of the subject in our school curriculum; for even now the subject is in a highly dynamic state, due to the rapid advances that modern discoveries in biological sciences have been making. Hence, changes in aims, subject matter, etc., to be properly understood, must be studied in the light of the conditions which gave rise to them.

George E. Nelson, in a recent article in School Science and Mathematics, divides the history of biological science in secondary schools into four periods which we may use as a background for our present discussion (47:34). The first period, covering nearly two hundred years, from 1635-1820, takes us back to the days of the Latin grammar school. Then biological science, where it was taught, was given in the form of natural history with the avowed purpose of developing a philosophical appreciation of the wonder of God's creation. This same spiritual or religious aim continued to animate the teaching of this subject during the second period, that is, from 1821-1864, when the influence of the academy was paramount. Biology was taught chiefly by means of text-books, and the purpose was to impart certainty to the mind and religion to the heart. Thus along with the religious aim the disciplinary value began to be recognized. The third period, 1865-1890, saw the establishment of biological studies in the curriculum on this basis. Besides the use of text-books, classification, drawing, and real laboratory work were introduced. This period also saw the rise of the high school, which became the dominant institution during the fourth and

last period, 1891-1927. This period has witnessed the greatest changes in the subject. The religious aim has been lost sight of. While the disciplinary continues to be prominent, various others are clamoring for recognition. The effort to show the relation of biology to life and life processes is especially marked, as is also the prominence given to the biology of man in its social and economic aspects.

With the first period of this development we have little to do beyond stating that biology had its origin in natural history. A scrutiny of the second period shows that the biological studies were either botany or zoology; biology as a science was taught in very few schools. Various reasons have been assigned for this, among others, that the fund of biological knowledge available in our day was then non-existent.

The aims of these two subjects were similar but the methods of treatment differed. Botany began with a study of morphology and classification, while zoology was devoted entirely to anatomy.

The numerous discoveries and inventions of the third period increased the popularity of science and gave an impetus to the development of such courses in the schools. Then besides the religious aim and the endeavor to prepare for the activities of life, the object of scientific training became disciplinary, that is, training in inductive reasoning.

The fourth period, the period of greatest change and progress, is the one in which we are chiefly interested. During the latter part of the third period dissatisfaction with biology courses was universal. It was in an attempt to remedy conditions somewhat that the Committee of Ten appointed by the National Educational Association published its report in 1893. Although this report did not have a very great influence on the biology

courses of the period, it was the first attempt to standardize these courses. Other agencies were at work securing the adoption of these sciences as high-school subjects with college entrance credits. Once this was accomplished the influence of the college in determining the content of the course became apparent, and there developed a type of biology course which consisted of some botany, some zoology, and some physiology.

During the first decades of the present century the adoption of biology as a high-school science made considerable progress. The statistical tables presented by Finley (23:21-27) show that from 1890-1920 biology had made the significant gain of 27.4 per cent. Meanwhile, current literature concerning biology was setting forth in concise terms the educational aims that could be attained by its adoption.

Abbott, in 1908, advocates a radical change in aim and method of treatment. "It (biology should by all means be a presentation of the dynamic aspect of the science rather than the static and should be made broad enough to cover the whole field, doing away with the distinctions involved in Botany, Ecology, Physiology, or Zoology" (2:194).

C.S.Gager, in the same year, makes a plea for social efficiency as an aim of the biology course, thus: "Social efficiency and individual happiness go hand in hand, and vary directly with the breadth of one's interests, his understanding of his environment and the correctness of the prospective with which he views himself and the men and things about him. The most nearly perfect adjustment depends upon the personal equations of knowledge, sympathy, and habits of thought.

"The high school curriculum, then, should include subjects which broaden one's interests, put him in touch with past events, make him intelligent about the phenomena that form part of his daily experiences,

enable him better to judge relative values, and train him in correct habits of thought and work. In how far does high school education fall short of doing this if biological science is omitted?

"I have emphasized the pedagogical basis for the study of biology in secondary schools. If the subjects are correctly taught, the information will result as a matter of course, and there is the scientific basis. A satisfaction of the informational and educative needs is, ipso facto, practical. Such questions as the national natural resources will be more surely settled aright by citizens whose education has been founded in harmony with the principles here indicated" (24:543).

Leading biology teachers continued to advocate a study of living things rather than classification and morphology, urging the necessity for a more comparative study of structure and function than the ordinary type-study method insures. At the same time the idea of teaching biology simply as a preparation for college was giving way before the urgent demands for more general education in the secondary school. This change in point of view brought about a change in the methods and content of the subject. As Biglow declares:

"More than anything else high school teachers of biology need to study more seriously the problems of teaching science with reference to the ideals of liberal secondary education considered as an end in itself rather than as college preparation. Viewed in this way the teaching of biology in the secondary schools becomes the selection and presentation, not so much of the facts as of the great ideas or principles which may be drawn from organized study of a series of plant and animal forms, and the unified course in biology becomes a logical necessity" (7:538-40).

This author then gives several reasons in favor of the unit course, the most important being:

- (1) It would solve curriculum problems.
- (2) There is nothing in the content of the science and in approved methods of teaching which opposes such a course.
- (3) A course in biology will tend to emphasize the great ideas or principles worth knowing.
- (4) There is no inherent reason why scientific discipline should not be as well developed as in any other high-school course in science.

The proposed change from botany and zoology to biology did not develop without opposition. An article on "General Biology for High Schools" published in 1909 contains the remark that "the appearance of several textbooks in general biology for high schools naturally raises the question of the advisability of adopting such a course instead of longer separate courses in botany and zoology" (17:454). In discussing the topic, the author gave two reasons similar to those quoted above in favor of biology; while against it he pointed out the following: (1) High-school students are too young to understand biological processes and laws. (2) It is too difficult to co-ordinate the course. The textbooks to date, are part botany and part zoology. Moreover, while he admits the possibility of making physiology the basis of unity, he points out the danger arising from the narrower point of view.

However, the movement for the adoption of the single science instead of the two continued, and we have H. E. Walter of Brown University setting forth the aims of an ideal course in biology as follows: "To summarize: The proposed ideal course in high-school biology demands (1) a study of

organisms in their living relations rather than morphological inquest upon their dead remains; (2) less of classification and identification of a species as an end in itself; (3) a more comparative study of structure and function than the ordinary type-study method insures; and (4) development in the pupil of a greater power and independence in interpreting the living world than seems to be possible through laboratory directions so detailed and complete that he is robbed of initiative which it would be the instructor's attempt to foster" (64:847).

T. W. Galloway lays down as the principles that should guide the formation of a course in biology: first, a leading general aim--the development and proper discipline of the intellectual, social, and ethical abilities; secondly, several special aims: (a) knowledge of life processes and an interpretation of man's place in nature; (b) a more accurate, dependable and efficient method of thinking; (c) a first hand knowledge of cause and effect. "This knowledge in addition to having great biological and general scientific values has ethical value of great importance". (d) knowledge of practical use, as well as a cultural knowledge of the relations of biology and industrial life, forestry, agriculture, and manufactures based upon the use of plant and animal materials (25:241).

Linville advocates some strikingly new ideas in regard to biology teaching when he says: "Besides teaching people how to think we need to teach them how to live" (39:210-216). He then sets down in fifteen statements the subject-matter calculated to secure these results from a course in biology, or "to make it (biology) serviceable by finding a basis of classification of the subject-matter which would bring ideas together in logical relation and give evidence that the well-being of human life is the

central idea. This central idea may be expressed in this form: "It is important to know how man in all environments comes into direct and indirect relations with many other organisms, both plants and animals, with non-living things and with conditions" (39:210-216).

W. L. Eikenberry, when analyzing the causes of the attempted general biology courses, criticizes the results and sounds a note of warning for the future. The cause he describes as "the peculiar seeming parallelism of botany and zoology that has tempted people to combine them in the form of a course in general biology". This attempt has failed because, (1) botany and zoology are in fact divergent rather than parallel sciences; (2) in respect to morphology they are widely divergent; (3) the makers of text-books and courses have largely ignored as the organizing principle the only thing in common between animals and plants--the phenomenon of life (22:518-20).

While admitting the possibility of a course organized around man's economic interests, Eikenberry takes occasion to point out the inadvisability of doing so and the danger of leaving great gaps in the presentation of the subject. Then he draws this same conclusion: "We must realize that a course in general biology is not made so by the title or by the binding of the book; that there is little in morphology that is common to the two sciences; that there are few life processes that are actually identical in the two sciences; and that in deriving a knowledge of these common facts a pupil can be instructed in either science, a general course not being a necessity.

"In these schools where pupils take both botany and zoology a great service might be performed by teachers who would attempt to instruct classes in certain fundamentals which are common to both sciences before

entering upon the separate courses, and reporting the results. There ought not be a complete organized course at first. Let it be an evolution. If there is but a single week's work of that sort the first year do that, and hope for future growth. If we ever have a real general biology course, it will be as the result of the experiments of those who are working with secondary school classes, and it will be the growth of years contributed to by many experiments. When a mass of results of this sort have accumulated and been placed on record it will be possible to answer positively the question as to how a course in general biology should be organized" (22:518-20).

Here should be noted the tendency to get farther and farther away from the conventional course in biology with the object of making biological principles more immediately applicable and the course itself more useful or practical.

By 1913, Morse, in his "Elementary Biologies," considered that experimentation had reached a stage to warrant his saying: "It is the firm belief of the present writer that the divisions of the subject into two grand divisions is a decided loss to the general student. Living things after all partake of the same general characters. The more plants are studied in terms of animals the better they have been understood. The best zoologist is he who has had, at the same time, the best botanical training. The great principles of science have been formulated by studies upon both plants and animals. A well-marked instance of this is the present-day work in sex, in growth, and the like. If this is true, why not give the student advantage of it?" (46:430).

Cyrus A. King, in dealing with the changes in teaching biology, formu-

lates these aims: (1) to teach the fundamental principles of life; (2) to emphasize the relation of biology to human welfare; (3) to develop citizenship. These aims he proves possible of attainment by the use of much illustrative material (37:67).

In favor of the unit course, G.W.Hunter makes the following plea:

"There are numerous reasons that might be given but I can think of none better than the rights of the child for whom the course is arranged. Children living in a rural or in an urban community meet all the factors of life. Zoology is not separate from botany; hygiene from anatomy; classification in science does not appear. If interested in life they wish to know something of life as it infringes on them from without; for example, plants and animals with their change and interchange, their give and take in daily activities. Life, in other words, should be interpreted as they see it in fields and streams and in their homes" (34:84).

In a discussion of the values of biology as a high-school subject we may agree that it possesses the abstract values common to all science. These according to Oberteuffer are: "It trains the child in close observation; it develops the powers of organization, comparison, and inductive reasoning; furthermore, science is a great developer of the imagination; and lastly, it provides valuable information. Biology as a science has these values" (49:366).

Besides these general values he mentions several others which are peculiar to biology because it differs so much in subject-matter and organization from the more exact sciences of chemistry, physics, and so forth. They include: (1) economic value, i.e., the value of biology in so far as it contributes to material well-being; (2) aesthetic value, i.e.,

the value arising from the love for the beauties of nature which it fosters; (3) ethical and social values, i.e., values arising from biological knowledge which leads to right conduct and from examples of social virtues as industry, cheerfulness, and unselfishness.

Though the author mentions the economic value first, he evidently does not consider it first in importance, as the conclusion of his article shows: "Our own course has been organized on a basis of emphasizing an aesthetic appreciation of the wonders and beauties of nature. Admitted that this is not practical and cannot be turned into money, yet we have other departments well organized and equipped to attend to this need. But in no course, with the exception of art and possibly literature, have we an equal opportunity of creating this aesthetic love and appreciation of the beautiful and the wonderful. The child today is apt to so over-develop in the practical, money-making, and livelihood-obtaining lines, that his future will be a sordid, mechanical existence, devoid of anything but artificial pleasure.

"Secondly, we attempt to develop powers of thinking, reasoning, and observation. Our laboratory work and field trips minister to this end. The economic and socializing values are of next importance to us in our teaching. The religious value would be spoiled if we attempt to teach it. But from time to time as we study and investigate this great truth comes to the child as an inspiring realization" (49:365-66).

Lloyd and Biglow, summarizing a lengthy exposition of the values of biology, arrive at somewhat similar conclusions: "It is pointed out that the method of thought is common to all sciences; therefore, that the special value of biology in education must be indicated chiefly by the nature

of the material with which it deals.

"The subjects of education are concerned with two classes of realities--feelings and things--and use respectively symbols and objects. The study of biology, because it is a study with objective realities, tends to develop the disinterested judgment, to teach the individual how to adjust himself to his surroundings and to raise the ideals of life.

"Biology has certain special values in education. First, it has been argued that biology has a special value in its usefulness in multiplying the interests of the mind, thus furnishing sources of pleasure which are deep and lasting and which produce no bad effects. They are such as are within the reach of all. We have especially emphasized the importance of the development of the aesthetic side of life as making for contentment and pleasure.

"Secondly, we have shown that biology has a special value as discipline. It is a complex and therefore a difficult study and calls for a large degree of caution in its method of thought. In this it resembles real life more nearly than the other natural sciences, and has educational value indicated by its similarity thereto.

"Thirdly, it has a humanistic value, measured by the amount and value of the information it brings. This information concerns various phases of human life as they have been affected by the application of biological science. We have cited the knowledge of the nature of many diseases, the field of agriculture and of labor, and the profoundly important matter of the relation of the sexes as being matters concerning which biology brings most valuable information, and so makes for a saner and more normal view of life" (41:23-24).

In 1918 the Commission on the Reorganization of Secondary Education published its "Cardinal Principles", containing the seven objectives which we have already seen are now the standard aims of secondary education. The Science Committee of that Commission made its report in 1920. In regard to biology it sets forth the following aims: "Biological sciences, in common with other sciences in secondary schools, should contribute to the educational objectives stated on page 12; health, worthy home membership, vocation, citizenship, worthy use of leisure, ethical character. In particular, biological sciences should have the following specific aims:

"(1) The World War has emphasized health as a basic end of education. So much of biology deals directly with problems of health, the course in biology must accept efficient health instruction as one of its chief and specific ends.

"(2) The biological sciences should develop the pupil's purposeful interest in the life of the environment by giving first-hand acquaintance with plant and animal neighbors.

"(3) They should emphasize some of the most important applications of biological science to human activities and to general and individual human welfare, and especially should they familiarize the pupil with the structure and functions of his own body, to the end that he may know why he must live healthfully in order to live happily and usefully.

"(4) They should train the pupil to observe life phenomena accurately and to form logical conclusions through the solution of problems and through projects essential to the productive work of agriculture, gardening, etc.

"(5) They should enrich the life of the pupil through the aesthetic appeal of the plants and animals studied, to the end that he may appreciate

Much wider in scope, hence not so specific though not fundamentally different, are the teaching objectives set forth in "A Year in Biology", by H. A. Cunningham. They are: "(1) In the first place, we aim at attaining a changed attitude toward life through the understanding and appreciation of the big fundamental principles of biologic science. (2) In the second place, we must 'develop the power to study' biologic science. (3) In the third place we must put the student in contact during the course with a very great variety of biological materials in the hope that he will develop a 'wide range of sustaining individual intellectual interests'. (4) In the fourth place we aim at developing, as a final product, an individual who is intellectually independent. (5) In the fifth place we shall aim to develop clear and forceful written and oral expression" (16:689).

Perhaps the most thorough analysis of the values of biology is that given by Millis. He states as his opinion "that there is no other study richer in its possible contributions to the equipment of youth for successful living" (43:306). This opinion he ably supports by a discussion of values according to his classification: I. Instrumental, II. Cultural, III Disciplinary. As Instrumental values he cites: (1) the necessity of biology in preparation for agriculture, medicine, surgery, physiology, sanitary engineering, and public hygiene; (2) the practical value to the gardener, farmer, stockman, orchardist, housekeeper, etc.; (3) the opportunity to teach the laws of health; (4) the opportunity for laying the foundation for ethics. As Cultural values he offers: (1) the intellectual delights, the deep emotional experience, the views of a world of entrancing beauty, all of which contribute to arousing permanent interests; (2) the liberalizing value, which gives the pupil a larger viewpoint for his thinking,

making him a citizen of the world of living things; (3) the value as a reconstructive agent in the mental and spiritual life of the pupil, which gives him a higher and larger viewpoint in which he himself occupies a less prominent place. As Disciplinary values he gives scientific observation, induction, classification, the use of the type concept in thinking and the concept of functional relations.

The latest writers on the subject seem to confirm the trend of the aims of biology. The discussions on high-school biology by college professors of botany, zoology, and physiology at the Illinois High School conference held at Urbana, November 7, 1927, brought out the following opinions:

1. "That the purpose of biology in a curriculum is three-fold; (1) as mental gymnastics or training, (2) to provide knowledge for advancement of agriculture and industry, (3) to promote health and prevent disease in plant, animal, and man" (6:87).

2. "The course should not be arranged with the sole idea of preparing the student for entrance examinations or for an advanced course in university or college, but for every day living" (60:81).

3. "The chief aim of the high school course should be to train the great mass of students for life--life which is biology" (42:79).

E. R. Downing in an article in School Science and Mathematics summarizes the aims of the biology course as follows:

"I. New skills based on a knowledge of biological laws and principles such as, skill in healthful living, skill in producing better plants and animals to serve man's needs.

"II. New emotional standards, ideals, and tastes that have been engendered by the self-sacrificing devotion of scientists, by new appreciation

of the significance of biological environment.

"III. That new attitude of mind called scientific, for which not biology alone, but all sciences are responsible" (18:497-505).

This classification, it will be seen, affords a much broader basis for the construction of a course in biology than any set of aims already stated. When the kind of skills necessary to attain the seven objectives of education have been determined and the types of motivation calculated to make these skills function most efficiently have been likewise agreed upon, the course in biology may be standardized somewhat. I say somewhat designedly for biological knowledge is still in such a state of evolution that a completely standardized course would be impossible as well as inadvisable.

From the foregoing discussion we see that biology appears to have made its way down from the college to the high school, not only because the teacher brought with him what his college training had given him, but also because of a series of changes in the aims and objectives of high-school sciences. The rapid development of biological sciences made vast amounts of knowledge of living things available in a non-technical form and so emphasized the value of such knowledge in the betterment of life in general that it became urgent to give this knowledge to the greatest number of people in the easiest possible way. At the same time, ever-increasing numbers of pupils crowded the high schools in search of a practical rather than a cultural education. Biology with its practical relations to life naturally offered an amount of organized information that was highly welcomed by school authorities. Thus biology has apparently come to stay in the high-school curriculum.

Yet its advent was gradual and the place assigned to it was by no means always certain. The content of the subject, also, varied as new viewpoints were taken, new theories were enunciated, and new discoveries made public. Hence Downing's statement in regard to science in general may well be made in education, the ever-widening outlook of science and its new applications make it necessary that the teacher be provided every few years with a restatement of the subject-matter of science available for instruction" (20:IX).

This restatement of subject-matter of biological science brings to light not only the new material for instruction but the change in methods of presenting this material, as well as the change in viewpoint regarding its value. Thus in 1872, Nicholson, in the Preface to Introduction to the Study of Biology, expresses the hope that his book will supply such knowledge as will be useful to "the student of living or extinct forms, or to the general reader" (48:). Even thus early, when biology was hardly thought of as a secondary-school subject, we find that the general public was kept in mind by the textbook writer.

Twenty years later, in 1891, Parker, in the Preface to Lessons in Elementary Biology, states the advisability of abandoning the principles of going from the simple to the complex in the study of living forms (50:vii). He designs his book for students who have studied botany and zoology as separate subjects. Moreover, he treats of biology as part of a liberal education and as such lays the plan of his text.

Sedwick and Wilson, in the Preface to the Second Edition of Introduction to General Biology, published in 1895, states: "It is hoped that the work as thus extended may serve a double purpose:-viz., either to be

used as an introduction to subsequent study in zoology, botany, or physiology, or as a complete course for general students to whom the minutiae of these more special subjects are of less importance than the fundamental facts of vital structure and function" (54:iii).

Some thirteen years later, when biology was making its first appearance as a high-school subject, Wilkens, in the Preface to Inductive Lessons in Biology, definitely states: "The purpose of this book is to supply a satisfactory guide for the study of general biology in the secondary school. Biology properly taught is the most important tool in the building of an education. The foundation of an education is logical thinking; one opinion supported by reason is worth more than a multitude of facts. Biology should teach, not only accurate observation but also correlation of the information acquired. Biology training in a secondary school of high-school grade should furnish the pupil with a reasonable number of facts in regard to plant and animal life, a realization of their relative importance, and the ability to use the same intelligently" (65:iii). Here we find the intellectual and cultural values predominating, while the practical first makes its appearance.

The development of biology as a high-school science during this period was accompanied by a corresponding diminution in the number of separate courses in botany, zoology, and physiology, as shown by data assembled by Finley in 1926 (23:21-27).

The tendency of the times is interpreted by Hunter in the Preface to his Elements of Biology, published in 1907. He thus sets forth the plan and purpose of his book: "The aim of this book is to correlate the allied subjects of botany, zoology, and human physiology in a general course of bi-

logy for the first year of high school. The foundation principles upon which this correlation is made are that life processes of plants and of animals are similar, and in many respects, identical; that the properties and activities of protoplasm are the same whether in the cell of a plant or of an animal; and that the human body is a delicate machine built of that same mysterious living matter--protoplasm. With such a foundation correlation is not only possible but natural" (30:5).

In 1908 Bailey and Coleman say of the purpose of their book, First Course in Biology, that it is an effort to meet the need for a simple and untechnical text to cover secondary biology in its elementary phases. This elementary biology, they decide, has been the result of a tendency in education to get away from the formal technical completion of separate subjects and to develop a workable training in the activities that relate the pupil to his own life. This tendency in the natural science field resulted in greater stress being placed on the processes and adaption of life as expressed in plants, animals, and man, than on the separate subjects of botany, zoology, and physiology. Also, it was a revolt against the laboratory and research method of the college that up to this time had dominated the high school science (4:V-VI).

Three years later, Hunter, editing another textbook, Essentials of Biology, recognizes first year biology as a science founded upon certain underlying and basic principles. These principles underlie not only biology but also organized society. The culmination of such an elementary course is avowedly the understanding of man, and the principles which hold together such a course should be physiological" (31:5). He then plans to present these principles in the form of plant physiology, repeat them under the

guise of animal physiology, and finally apply them to man, holding that the difficulty of understanding these physiological processes makes the repetition advisable, even necessary.

In the same year Sharpe, editing a laboratory manual, declares: "Most teachers of biology in secondary schools today aim to emphasize the biological relations of plants and animals from a physiological stand-point. The practical aspect is also becoming more and more recognized as most desirable, as opposed to the strictly educational and cultural functions of this subject" (55:3-4).

Peabody and Hunt in Elementary Biology, published in 1913, group all the activities of a plant, of an animal, or of a man into three classes--one class embracing the nutritive functions, another, the reproductive functions, and a third, their relations to one another and especially to the general welfare of mankind. Then, reasoning that the average student of fourteen is more interested in function than in structure, they conclude that it is easier to unify a course in biology on physiological than on morphological lines. Considering also the nature of the problems of the growing youth and that the kind of questions uppermost in his mind deals with the relation of the living world to human life, the authors also find possibilities for great practical value in the subject.

Textbook authors rather generally claim that their books deal with biology rather than botany and zoology as separate sciences. In 1913, Biglow has in the preface of his book the following statement: "This book is not a combination textbook of botany and zoology, for it makes no attempt at a systematic presentation of either of these sciences. It is simply what its title suggests; an introduction to biological facts and ideas. These have

been selected with reference to their direct bearing on the life of intelligent citizens.

"In short this is an introduction to biology considered as a science applicable to human life especially in economic or practical and hygienic lines, with limited attention to facts and ideas whose applications are aesthetic and intellectual" (8:v-vii).

Here we see that the practical side of the subject is entirely to the fore, with the intellectual and cultural values relegated to second place.

In regard to the substitution of the one science, biology, for the three on which it is based, Abbott, in his General Biology, published in 1919, says: "The artificial division between the study of plants and that of animals is becoming increasingly difficult to maintain, **inasmuch as** some biological principles are best illustrated by phenomena in the plant world, others by those of the animal world". He further designates that the purpose of his book is to supplement the facts acquired in a laboratory course and to be of use to the general reader by giving him a simple statement of those fundamentals of biology which are becoming increasingly important in our everyday life" (1:iv).

Gruenberg, in his Elementary Biology, published in the same year, strikes the same note. "In the selection and arrangement of material I have tried to avoid the specialist's divisions into botany, zoology, etc. I have tried to stress the dynamic by speaking of what plants and animals do and how they do these things. So far as possible each main division deals with plants and animals including man, except where the topic is specifically related to one or another group" (27:3).

Biology for High Schools, published by Smallwood, Reveley, and Bailey

in 1920, has for its avowed purpose to show the close relationship of the science of biology to human life. The aims of the book are stated thus: "(1) To teach the pupil to see accurately what he looks at and describe accurately what he sees. (2) To teach him to think clearly and to base his conclusions upon his facts. (3) To broaden his knowledge of his own body through the study of the structure and function of other animals and of plants. (4) To show him by the adaptations of plants and animals how he can adapt himself to the varying conditions of life. (5) To make him a good citizen through his knowledge of food, good health, and good living conditions. (6) To teach him how biology has helped human progress and welfare" (57:V).

Here we find that (1) and (2) are general educational or intellectual aims. The remaining four pertain to the practical value of the subject by relating it directly to the student's life.

A further development of this practical side of the subject is brought out by Burlingame and others in General Biology, published in 1922. The Preface includes this statement: "General biology aims to bring together and present to the non-specialist those aspects of Biology which it is important that everyone should understand in order to perform his duty as a citizen in an intelligent manner" (11:5). Here the aim is evidently good citizenship.

The endeavor to subordinate biological facts to biological principles is evident in all the latest textbooks. Clement, in the Preface to Living Things, published in 1924, says: "It should be one of the purposes of a biology course to teach the great ideas or principles that underlie all life. The best way to assure this is to ascertain as soon as possible what

these principles are and then to explain their workings as applied to animals, plants, and man" (15:iii).

The author divides his book into five parts. Part One explains these great ideas or principles; Part Two applies these principles to animals; Part Three, to man; Part Four, to plants; Part Five discusses the interrelations of man, animals and plants, together with problems relating to the health of man.

Smallwood, Reveley, and Bailey in New Biology, published in the same year, adhere to the same principles and their book treats of much the same topics in a similar order. However, the educational and cultural aims are also given an emphasis which in some companion texts is entirely lacking. The following quotation from the Preface shows clearly what the authors have in mind:

"The New Biology offers a unit course dealing with the fundamental functions of living things. But owing to the fact that different animals and plants may be used equally well in a study of these processes, we offer a wider selection than the minimum requirements. We are coming to realize more and more that it is what an organism does that is important rather than the details of its structure, and this is the reason that we have departed somewhat from the older type study which has characterized earlier texts on biology. Biology will take its recognized place as a valuable subject in training only when teachers require accuracy of observation and the recording of these observed facts in suitable note-books. It is possible to learn much about our own lives from a study of animals and plants, but trustworthy conclusions can be formulated only from reliable observations. We have suggested a method of study in the laboratory prob-

lems to train the student in accuracy of observation and recording. All the remarkable progress in biological information has come through the pains-taking observations of many scientists who by their contributions have made the world a better place to live in. But in our zeal to apply these brilliant discoveries to human welfare, we must not overlook the beauty of biology; and, as we attempt to understand life, let us not miss the delight that comes from simply knowing animals and plants in their homes. The first spring flower and the first immigrant bird herald the coming of spring. These in turn are followed by so many living things that every excursion to parks and woods throughout the summer and fall furnishes one with the most varied program of entertainment. Even the winter supplies opportunities for the study of animals and plants that have now become our friends. One is richer and happier who has such a store house of pictures to enjoy when his duties do not permit him to wander afield" (58:iii-iv).

A third text belonging to the class mentioned above is edited by T. J. Moon, Biology for Beginners. In the Preface the author merely states: "The course here presented emphasizes the fact that biology is a unit science based upon the fundamental idea of development, rather than a forced combination of portions of botany, zoology, and hygiene" (45:V). But, in his introduction he gives the student several reasons why he should study biology. With him the cultural value receives first place and is followed by the intellectual or educational value, while the practical and personal values are placed last.

Biology and Human Life, edited by Gruenberg in 1925, gives an additional reason for teaching biology as a basic science: "namely, the rapid

extension of secondary-school opportunities to new population groups. The high schools now receive increasing numbers of boys and girls whose interests and aspirations are radically different from those of earlier generations of pupils. The high school is no longer primarily or chiefly a college preparatory institution. More and more of our students are concerned with the concrete and the practical rather than with the abstract and theoretical. Boys and girls who look forward to an early entrance upon occupational activities and the responsibilities of earning and spending money have as much need for the study of biology as those who plan to go to college or the professional schools" (28:v).

Gruenberg, together with the authors of two other texts, Hunter in New Civic Biology (32) and Waggoner in Modern Biology (63), both published in 1926, gives a place of prominence to the report of the Commission on the Reorganization of Secondary Education regarding the "Reorganization of Science in Secondary Schools". Gruenberg says that this report lays down the principle of a synthetic treatment of biology. This attitude developed by Hunter and Waggoner in their texts, is recognized by Finley in Biology in Secondary Schools. "The course (in biology) has been and still is of two types: one in which the year's work is divided into three parts treating each of the three sciences, botany, zoology, physiology; and the other in which the subject matter of the sciences is grouped around topics of problems, such as food, life-processes, reproduction, struggle for existence, and others" (23:16).

The texts so far discussed, with the exception of Gruenberg's Elementary Biology, while laying down the principle of biology as a basic science, developed their idea by first explaining biological principles and then

applying them to plants, animals, and man in separate sections so as Gruenberg says: "The change (i.e., the synthetic treatment of biology) seems to have gone no farther than the substitution of "plant biology" for botany, "animal biology" for zoology, and so on (28:V).

Gruenberg in both Elementary Biology and Biology and Human Life, (27, 28), Hunter in a New Civic Biology, (32) and Waggoner in Modern Biology; Its Human Aspects (63) develop the subject in the form of problems which illustrate biological principles using plants, animals, or both, as the importance of the problem demands, and applying the principles thus explained to human welfare.

CHANGES IN CURRICULAR CONTENT

With the constantly changing aims came a necessary changing of curricular content of high-school biology. While the course consisted of botany or zoology or both there was little difficulty, because the aim was observation or classification, and the textbook furnished the fundamentals for a classified study of all types of animals and plants, and the laboratory guides were so detailed that "observation" became mere verification. However, when biology teachers began to see the other values inherent in the subject if the study of life and life processes were used, the difficulties of deciding just what topics to include in the curriculum became at once apparent. Moreover, as we have seen, the change in point of view was not a radical one, but a gradual development. Hence the change in curricular content shows the same characteristics.

In 1908 Gruenberg offered the following suggestions: "The scientific bases for the study of Biology are the fundamental problems that apply to living things: (1) comparison of living and non-living; (2) properties of protoplasm and the activities and capacities of organisms conditioned thereby; (3) the notion of life as an adjustment; (4) the conditions essential to life and the limitations upon its continuance; (5) the essentials of nutrition, the nitrogen, carbon and oxygen balances; (6) the relations of plants and animals to each other and to man; (7) interdependence, types of symbiosis, communal life; (8) organization as integration and differentiation; (9) reproduction and the essentials of sex; (10) tropisms, taxes and instincts; (11) increasing importance of consciousness in utilization and control of environment; (12) evolution and man's place in nature" (26:540).

This outline may appear somewhat difficult for high-school students. In fact, much of it is such as has its proper place in college biology. Certainly the criticism of Densmore (17:454) that high-school students are too immature to understand biological laws and principles would be justified if all the items mentioned above had to be incorporated into the course.

Linville, in an endeavor to make biology a more popular and practical subject, advocates a reorganization of the course on the basis of life interests. He would include the following topics:

- "1. The sources and biological importance of food.
- "2. The relation of organisms to man in food production and food destruction.
- "3. The hygiene of food preparation and food digestion.
- "4. The use, mechanism, and hygiene of circulation and respiration.
- "5. Sanitation.
- "6. The scientific and trustworthy teaching of the effects of alcohol and narcotics.
- "7. The nature of the risks taken in using patent medicines.
- "8. Protection-yielding organisms; the sources of clothing and organic building material.
- "9. The conservation of our natural resources.
- "10. The usefulness of the beautiful in nature.
- "11. The organic causes of disease.
- "12. The conditions of the extermination of disease.
- "13. The social agencies for the protection of the health and well-being of the race.
- "14. Sex and sex hygiene.

- "15. Acquaintance with other organisms in their genetic and ecological relations" (59:210-16).

The author acknowledges that this is not the subject-matter of conventional biology, but pleads that if biology is to be of service in teaching how to live, it must treat of the matter of life.

The Commission on the Reorganization of Secondary Education in its report on the Reorganization of Science in Secondary Schools" declares its belief that a course in biology should be what its name implies--a study of living things; and gives four central ideas around which the course may be grouped:

- "1. The way in which each organism maintains its own life and the life of the species.
- "2. The interrelations between different organisms and groups of organisms.
- "3. The constant dependence and interrelations of living things with the physical world about them.
- "4. The power of man to control the habits and relationship of plants and animals to serve his own ends" (62:31).

The further explanation and demonstration which the committee gives places the course on the high-school level. At the same time it is careful to point out that curricular content may and should change with the requirements of a given locality.

In a discussion of "The Possibilities of a Required Course of High School Biology" at the High School Conference held at Urbana, Ill., in 1921, Mr. Hunter gives the following topics as advisable for a course in elementary biology: "1. The primary needs and functions of living things.

2. The relations of the factors of the environment to these primary needs.
3. The application of the laws of hygiene and sanitation to the individuals within their environment.
4. The need of the conservation of natural resources.
5. The economic relations of plants and animals to man.
6. The pleasurable appreciation of nature gained by contact with living things.
7. A slight acquaintance with the work of some great biologists that have contributed to human welfare.
8. Last, and most important, the development of the scientific attitude of mind" (34:87).

At the same conference Miss Pearl T. Brown gives her opinion of the content of the course: "With coherence and unity of subject-matter throughout, the course in general biology should emphasize: 1. The physiology and hygiene of sex reproduction. 2. The evolution of plant and animal structure. 3. The ecological value of plants, a determining feature in Agriculture. 4. The eradication of certain bacteria including harmful diseases to man. 5. Metabolism of plants and animals. 6. Plants and animals useful and harmful to man. 7. Correct views of life processes resulting in better health and a better ethical character. 8. The development of interests of life through environmental study of plants and animals. 9. The beauty of nature contributing to the enjoyment of right living. 10. The value of hard scientific training in progress and development" (11:91-92).

Curricular studies were carried on with a view to procuring some statements of the ideas and interests of teachers and students. Considerable work along these lines was done by the Committee of a One-year Fundamental Course of Biological Science appointed by the Biology section of the Illinois High School Conference in November, 1921. The report of the committee read by the chairman, G. W. Hunter, at the conference in Novem-

ber, 1922, is based on these activities. Students' opinions were drawn from a questionnaire that had been sent out to almost 2500 high-school students in the eastern states some years previously. The biological matter which these students considered most important was indicated in the following order: (1) problems relating to the improvement of environmental conditions, (2) problems relating to health, (3) problems relating to the working structure of the human body, (4) problems relating to certain factors in their environment, (5) problems relating to the economic importance of certain biological materials, (6) problems relating to habits of efficiency and method in the laboratory, (7) problems relating to sex understanding and sex health, (8) problems relating to worthy citizenship" (35:94).

Then, as a foundation for their proposed course, the committee sent out a questionnaire to the biology teachers of the state of Illinois. The questionnaire was divided into several parts: viz.; I. Living things in relation to their environment. II. Interdependence of living things. III. Life processes in plants and animals. IV. Green plants as living organisms. V. Animals as living organisms. VI. Responses in plants and animals. VII. Reproduction in plants and animals. VIII. Evolution. IX. Man's control of his environment. These parts were sub-divided so that there was a total of 98 items to be checked and the subject in the curriculum of which each at the time formed part was to be designated. A significant result was that 84 of the 98 items were taught by 90% of the schools, although only 34% of the schools reporting offered biology. Hence, the greater amount of this biological knowledge was being presented to students in other sciences. However, this is a local condition, and Mr.

Hunter says in his report in 1924 that it is at variance with the conditions of the country in general. Similar studies summarized and interpreted by Finley (23:21-27) corroborate this opinion of Mr. Hunter.

A study of the status of Biology in the North Central States made by Reusser in 1923 gave the following topics as those considered most useful by the teachers answering his questionnaire:

- (1) "Structure and function of organisms.
- (2) "Interrelation between organisms and groups of organisms.
- (3) "Adaptations of organisms to their environment.
- (4) "Man's ability to control the habits and relationship of plants and animals to serve his own ends" (51:259).

It will be observed that these topics are almost identical with those recommended in the report on the "Reorganization of Science in Secondary Schools". However, the report of that Committee announces in the Preface that "some of the improvements that the committee sought to effect have already been adopted by the best schools. The full report incorporates... practices that have proved most useful. It asks for only those features of reorganization that have been found to work well, or which by a fair amount of trial promise improvement" (62:10). Hence it does not argue an immediate phenomenal influence for the report of the committee to find that three years after its publication a group of teachers in the North Central States are in accord with its policies.

In fact, the conclusions of a study carried on by O. W. Richards, which consisted of an examination of syllabi, texts, etc., from school systems in 59 cities whose population was over one hundred thousand does not give any such encouraging result. His conclusion is this: "The main fact

brought out is that biology is not at all standardized and is taught in such a variety of ways that any given course could be evaluated only by a knowledge of the efficiency and training of the teacher, together with actual observation of the work given in the classroom" (52:146).

The tendency already referred to (35:94) of taking the child's interests as a basis for curricular content was part of a movement to get away from the old methods of teaching that had come down from the college--that is, "to abandon the teaching of biology for biology's sake in order to teach it for the sake of the student". Such is the conclusion reached by Klingensmith and Giordini through a study of Biology text books: "The present study shows that we are getting away from the idea of teaching Biology as systematized sciences like zoology, botany, etc., and are approaching a method of presentation and attack which is more suitable to the child's understanding and method of thinking" (38:584).

Downing is of the same opinion. He says: "We know from the studies of Mau, Finley, Trafton, and others that pupils are interested primarily in the activities of animals and plants, their identification and relation to the environment--not in their structure, classification, utility. Further, that the interest is chiefly in birds, insects, and common mammals among animals, and in wild flowers, trees and garden plants. Our biology should deal with these groups and it should be chiefly concerned with behavior and environmental relationships" (19:743-45).

Again, we have Hunter making another curricular study in 1923. A comparison with the study made in 1908 by the same author was published in the School Review, May, 1925. One question called for information concerning the biological subject matter on which most emphasis was being placed. From

the summarized results the author concludes: "The situation indicates a decided change in the teaching of biological subject-matter in the secondary schools. Health and human biology and the relations of biologic phenomena to the well-being of man are the phases which loom largest in the perspective of high school teachers. The teaching of morphology is apparently only used in so far as it may explain physiology. The teaching of natural history particularly in its ecological and taxonomic aspects has lost ground" (34:461).

The "Report of Biology Teachers on Recommendations for a New Course of Study for the High Schools of Chicago", published in 1920, contains an outline of biological topics applied to the cardinal aims of education. Without reference to the relative importance of topics the following values are implied.

- "1. Health, derived from the knowledge of biological subject-matter relating to health--i.e., disease, sanitation, etc.
- "2. Disciplinary values, derived from the greater proficiency in fundamental processes.
- "3. Preparatory values, derived from the training which prepares for worthy home membership and future vocations.
- "4. Civic or social--the knowledge and training which aid in preparing for good citizenship.
- "5. Aesthetic--knowledge and training which prepare for worthy use of leisure.
- "6. Ethical--knowledge and training which secures co-operation, regard for laws, etc."

Moreover, this report lays much stress on the values of biology as a

high-school subject. It prefaces the above mentioned outline with these statements: "We hold that biology is unique among secondary school subjects when properly taught, in serving a greater number of ends of education than any other single subject and that it should furnish a part of the training of every boy and girl who is to contribute to the breadth and depth of democracy, in which each is later to take an active part. In support of the contention just stated, we desire to show in concrete form the extent to which biological knowledge contributes to the seven objectives of education" (36:642-44).

SUMMARY AND CONCLUSIONS

Summarizing the above changes in biology, we find the following:

1. There has been a series of changes in the general aims of the subject.

(a) The aim of the earliest biological subjects was religious, or to give the students a philosophical appreciation of the works of the Creator (1635-1820).

(b) Besides the religious aim there appeared the cultural and the disciplinary values (1821-1891).

(c) The religious aim was lost sight of and the practical value made its appearance (1864-1891).

(d) As biological subject-matter was made more readily available the practical value became increasingly important, but at the same time the cultural and disciplinary values held their places (1891-1927).

(e) The latest tendency has been to define the aims of biology in terms of its contributions to the seven objectives of education.

2. The more immediate purpose of the course has changed from preparation for the college entrance requirements to preparation for life's activities.

3. There has been a progressive change in form from natural history to botany or zoology, then to a course composed of botany, zoology, and physiology, and finally to the unit course of biology.

4. There have been various changes in the method of teaching the subject matter: from the study of the text in the early botany and zoology classes, to the collection and study of specimens, thence to the use of

laboratory work in which the conditions of the experiment were carefully controlled, thence to the study of living forms, and finally to the course organized in projects or problems.

5. Very marked have been the changes in the basis of unification of the course--namely, from morphology to physiology, then to life processes, and finally to the economic, social, or civic aspects of the course.

6. The curricular content has varied with the aims, methods, form, and basis of unification.

Hence we conclude in regard to biology as a secondary school subject that:

(a) The aims considered most important are those included in the seven objectives enumerated in "Cardinal Principles of Secondary Education"--namely, health, fundamental processes, worthy home membership, vocation, citizenship, worthy use of leisure, ethical character.

(b) The most important values are the practical or instrumental, the cultural, and the disciplinary.

(c) The curricular content is not at all standardized; each theorist or textbook writer includes the topics that best illustrate his point of view.

(d) The course now consists of either biology taught under the form of plant, animal, and human biology, or of a unit course arranged in problems or projects on the basis of life processes, for the purpose of stressing the economic, the social, or the civic aspects of the subject.

AIMS AND VALUES ACTUALLY ACHIEVED

In view of the fact that the seven objectives set forth in "Cardinal Principles of Secondary Education" (61:10) are the outstanding aims of our biology courses, an interesting problem presents itself. Are we with our present variety of form, method, etc., actually attaining any or all of those ends? Does biology really contribute to secondary education the values claimed for it by its advocates? In other words, can biology be made to function to such an extent in secondary education as is believed by its adherents?

Before attempting to answer these questions let us look again at these seven objectives of education. In discussing them W. S. Monroe points out in his recent book, Directing Learning in the High School, that "they describe the conduct of educated persons rather than the peculiar abilities or controls they possess" (44:53). He also suggests that teachers classify their immediate objectives as:

1. Fixed controls of conduct (specific habits);
2. Adaptive controls of conduct (knowledge);
3. General patterns of conduct (general controls);

Restating our question: What specific habits, what knowledge and what generalized controls are actually secured by the biology course in secondary schools?

An effort was made to get some information on this question by the use of the questionnaire. In order that the results, when secured, might be more easily classified and applied, the seven objectives were made the basis of the questionnaire. Then each objective was divided into a number of

parts covering values claimed for biology by the "Report of Biology Teachers on Recommendations for a New Course of Study for the High Schools of Chicago" (36:642-44) and worded in such a way as to bring results classifiable under the terms specific habits or abilities, knowledge, and generalized ideals. Seven hundred and eighty copies were distributed among high-school students, high-school graduates, teachers, biology teachers, nurses, and doctors, and four hundred and forty-five replies were received. Of that number one hundred and sixty were answered by college students, one hundred and two, by teachers of subjects ranging from kindergarten to college; sixty, by seniors in high school who had taken biology in the early part of their course; forty-seven, by high-school graduates engaged in various professions, some of whom were married; thirty-four, by nurses; twenty-six, by teachers of biology in high school and college; and sixteen, by doctors.

The following table presents a summary of results. The order in which the seven objectives are usually quoted has been changed to represent the order of importance as shown by the percentage of total affirmative answers to each objective. The subdivisions have been similarly arranged, and the groups, according to highest percentage, read from left to right.

1. Benefits in regard to training in
Fundamental Processes

		Biology Teachers 100	High-School Students 100	High-School Graduates 95.4	Doctors 93.3	Nurses 70.2	Teachers 91	College Students 90	Total 90.4
1. Biology helped me to observe accurately.....	Yes								
	No	0	0	4.6	6.7	29.8	9	10	9.6
2. Biology helped me to analyze.....	Yes	96.1	91.7	91.5	87.5	77.6	90	90.5	89.5
	No	3.9	8.3	8.5	12.5	22.4	10	9.5	10.5
3. Biology helped me to reason.....	Yes	88.4	90	87.1	85.7	76.5	80	83.1	81.7
	No	11.6	10	12.9	14.3	23.5	20	16.9	18.3
4. Biology helped me to judge.....	Yes	88.4	88.4	80.8	66.6	82.4	82	76	80
	No	11.6	11.6	19.2	33.4	17.5	18	24	20
5. Biology helped me to express my thoughts more clearly.....	Yes	69.2	77.6	80.8	75	70	63	62.5	67.6
	No	30.8	22.4	19.2	25	30	37	37.5	32.4

II. Benefits in regard to Health.

1. Biology increased my ability to protect myself against insect disease carriers, as flies, mosquitoes, etc.	Yes	96	87.2	94.4	100	88.3	94.1	82	90.3
	No	4	12.8	5.6	0	11.7	5.9	18	9.7
2. Biology increased my ability to protect myself against contagious diseases.....	Yes	92	92.2	88.2	100	63.6	91.8	85.5	87.5
	No	8	7.8	11.8	0	36.4	8.2	14.5	12.5
3. Biology increased my ability to secure sanitary living conditions.....	Yes	100	93.3	78.7	81.3	82.4	89.7	85.6	85.7
	No	0	6.7	21.3	18.7	17.6	10.3	14.4	14.3
4. Biology increased my ability to secure the proper amount of fresh air.....	Yes	81	88.3	85	53.7	76.4	80.1	70.6	87.3
	No	19	11.7	15	46.3	23.6	19.9	29.4	12.7

		Biology Teachers	High-School Students	High-School Graduates	Doctors	Nurses	Teachers	College Students	Total
5. Biology increased my ability to	Yes	65.3	86.6	76.1	87.5	63.6	75.2	66	72.5
secure pure food.....	No	34.7	13.4	23.9	12.5	36.4	24.8	34	27.5
6. Biology increased my ability to	Yes	80.8	86.6	78.9	62.5	55.9	68.4	68.2	71.5
secure the proper elimination	No	19.2	13.4	21.1	37.5	44.1	31.6	31.8	28.5
of waste matters from the body..									
7. Biology increased my ability to	Yes	80	76.5	74.4	100	73.5	72.4	60.6	70.4
protect myself against animal	No	20	23.5	25.6	0	26.5	27.6	39.4	29.6
parasites, as ringworm, etc.....									
8. Biology increased my ability to	Yes	85.6	74.6	72.3	100	79.4	77.6	58.1	69.5
protect myself against diseases	No	14.4	25.4	27.7	0	20.6	22.4	41.9	30.5
carried by mammals such as rats.									
9. Biology increased my ability to	Yes	85.6	94.3	80.9	68.8	58.8	71.6	73.1	67.6
maintain bodily cleanliness.....	No	14.4	5.7	19.1	31.2	41.2	28.4	26.9	32.4
10. Biology increased my ability to	Yes	97.4	60	73.8	68.8	61.7	73.5	58.1	65.7
determine and follow a properly	No	2.6	40	26.2	31.2	38.2	26.5	41.9	34.3
balanced diet.....									
11. Biology increased my ability to	Yes	96	62.6	58.7	87.4	52.9	68	52.3	61.7
make proper use of medicines....	No	4	37.4	41.3	12.6	47.1	32	47.7	38.3

III. Benefits in regard to Ethical Character.

1. Biology increased my desire to									
do my share to make the world	Yes	100	91.7	86.6	75	71.1	85	81.7	84
a better place to live in.....	No	0	8.3	13.4	25	28.9	15	18.3	16

		Biology Teachers	High-School Students	High-School Graduates	Doctors	Nurses	Teachers	College Students	Total
2. Biology showed me where and how to find useful occupation for my Yes	leisure hours.....No	91.9 8.1	86.7 13.3	72.6 27.4	68.8 31.2	68.8 31.2	70 30	67.6 32.4	70.2 29.8
3. Biology increased my ability to Yes	co-operate with others.....No	80.8 19.2	76.6 23.4	75.6 24.4	50 50	59.4 40.6	68 32	64.5 35.5	68.1 31.9
4. Biology increased my respect for Yes	law.....No	80.8 19.2	68.4 31.6	75.6 24.4	50 50	60.5 39.5	64 36	56.9 43.1	62.7 37.3

IV. Benefits in regard to Worthy Home Membership.

1. Biology broadened my concept of Yes	the principles of reproduction....No	96.3 3.7	94.9 5.1	95.7 4.3	100 0	97 3	94 6	97.4 2.6	96.2 3.8
2. Biology gave me helpful knowledge Yes	of the relation of sex.....No	87.5 12.5	80.2 19.8	89.3 10.6	93.7 6.3	82.2 17.8	89 11	90.6 9.4	88.1 11.9
3. Biology gave me helpful ideas in regard to the value of food and Yes	clothing.....No	92.4 7.6	86.4 13.6	75.7 24.3	57.2 42.8	55.8 44.2	81 19	79.3 20.7	78.3 21.7
4. Biology helped me to understand Yes	my place as member of a family....No	68 32	69.4 30.6	68.1 31.9	50 50	58.9 41.1	68.1 31.9	57.8 42.2	64.1 35.9
5. Biology gave me a truer idea of Yes	the relative value of luxuries....No	66.8 33.2	57.5 42.5	56.9 43.1	46.7 53.3	50 50	60 40	53.8 46.2	56.3 43.7
6. Biology helped me to live econom- Yes	ically.....No	69.2 30.8	58.3 41.7	52.1 47.9	87.4 12.6	50 50	45 55	34.4 65.6	45.4 54.6

V. Benefits in regard to Worthy Use of Leisure.		Biology Teachers	High-School Students	High-School Graduates	Doctors	Nurses	Teachers	College Students	Total
	Yes	84	100	95.5	87.5	84.8	99	97.4	95.3
1. Biology helped me to enjoy nature...	No	16	0	4.5	12.5	15.2	1	2.6	4.7
2. As regards flower culture bio- logy resulted in an increase	Yes	100	100	98.9	75	80.1	93.6	74.4	86.7
of interest.....	No	0	0	1.1	25	19.9	6.4	25.6	13.3
3. Biology increased my appre- ciation of beauty.....	Yes	84.6	91.3	90.9	68.8	80.7	93	81.8	83.8
	No	15.4	8.7	9.1	31.2	39.3	7	18.2	16.2
4. As regards bird study biology resulted in an increase of	Yes	92	96.6	85.1	68.7	96.7	89.8	69.5	83.2
interest.....	No	8	3.4	14.9	31.3	3.3	10.2	30.5	16.8
5. As regards excursions biology resulted in an increase of	Yes	77	74.7	88.1	87.4	90.8	71	54.9	70.3
interest.....	No	23	25.3	11.9	12.6	9.2	29	45.1	29.7
6. As regards gardening biology resulted in an increase of	Yes	68	72.9	84.5	94.8	90	72.1	56.1	69.5
interest.....	No	32	27.1	15.5	5.2	10	27.9	43.9	30.5
7. As regards fishing and hunting biology resulted in an increase	Yes	91.6	72.4	79.5	75	96.7	37	48	59.1
of interest.....	No	8.4	27.6	20.5	25	3.3	63	52	40.9
8. As regards insect collecting bio- logy resulted in an increase of	Yes	72	72.9	79.9	73.3	68.7	51.4	39.4	56.8
interest.....	No	28	27.1	20.1	26.7	31.3	48.6	60.6	43.2

		Biology Teachers	High-School Students	High-School Graduates	Doctors	Nurses	Teachers	College Students	Total
9. As regards poultry keeping biology resulted in an increase of interest.....	Yes	88.5	31.5	75	93.8	90.8	24.5	21.1	40.5
	No	11.5	68.5	25	6.2	9.2	75.5	78.9	59.5
10. As regards bee-keeping biology resulted in an increase of interest.....	Yes	80.8	40.3	81.8	94.8	87.1	21.6	23.5	41.5
	No	19.2	59.7	18.2	5.2	12.9	78.4	76.5	58.5

VI. Benefits in regard to Citizenship.

1. Biology increased my interest in seeing the fly and mosquito nuisance reduced for the public welfare.....	Yes	100	98.3	93.6	100	88.3	95	94.3	95.3
	No	0	1.7	6.4	0	11.7	5	5.7	4.7
2. Biology increased my interest in seeing scale insects and weeds controlled for the public welfare.....	Yes	100	96.6	89.3	93.7	88.2	92.5	81.8	89.3
	No	0	3.4	10.7	6.3	11.8	7.5	18.2	10.7
3. Biology increased my interest in seeing that birds be protected for the public welfare.....	Yes	100	100	90	87.5	85.3	93.5	75	89.2
	No	0	0	10	12.5	14.7	6.5	25	10.8
4. Biology helped me to realize and to discharge my duties as co-operator.....	Yes	88.5	76	64.6	50	50	60.6	60.7	62
	No	11.5	24	35.4	50	50	39.4	39.3	38
5. Biology helped me to realize and to discharge my duties as neighbor.....	Yes	73	56.9	60.5	46.7	50	57.8	59.6	57.5
	No	27	43.1	39.5	53.3	50	42.2	40.4	42.5

6. Biology helped me to realize and to discharge my duties as taxpayer.....	Yes	52	17.3	38.1	37.5	33.2	37.4	20.4	29.4
	No	48	82.7	61.9	62.5	66.8	62.6	79.6	70.6

7. Biology helped me to realize and to discharge my duties as voter..	Yes	48	11.6	30.3	46.7	18.7	32.6	20.7	25.8
	No	52	88.4	69.7	53.3	81.3	67.4	79.3	74.2

VII. Benefits in regard to choice of Vocation.

1. Biology gave me valuable general information in regard to forests and fisheries.....	Yes	100	100	82.5	68.8	82.4	84	72.4	81.8
	No	0	0	17.5	31.2	17.6	16	27.6	18.2

2. Biology gave me valuable general information in regard to medicine (antitoxin, etc).....	Yes	91.2	79.4	61.7	87.5	47.1	77	60.1	70.3
	No	8.8	20.6	38.3	12.5	52.9	23	39.9	29.7

3. Biology gave me valuable general information in regard to nursing (first aid, etc).....	Yes	88.4	71.6	59.6	62.8	58.8	65	55	62.4
	No	11.6	28.4	40.4	37.2	41.2	35	45	37.6

4. Biology gave me valuable general information in regard to house-keeping (cleaning etc).....	Yes	81.9	46.7	51.1	50	52.9	59	34.6	47.8
	No	19.1	53.3	48.9	50	47.1	41	65.4	52.2

5. Biology gave me valuable general information in regard to art.....	Yes	46.1	51.7	36.9	26.6	25.8	53	44	45
	No	53.9	48.3	63.1	73.4	74.2	47	56	55

6. Biology influenced me in my choice of vocation.....	Yes	27	36.6	29.8	26.6	32.3	25	16.2	24.8
	No	73	63.4	70.2	73.4	67.7	75	83.8	75.2

DISCUSSION OF RESULTS

A careful perusal of these results shows many interesting facts. First, the percentage of total affirmative answers shows that each of the seven objectives of education can be realized by the study of biology in high school. Secondly, the objectives in the order of importance given them by those replying to the questionnaire are Fundamental Processes, Health, Ethical Character, Worthy Home Membership, Worthy Use of Leisure, Citizenship, Vocation.

It may be somewhat surprising that the first place is given to Command of Fundamental Processes, one of the outstanding objectives of elementary education. This fact calls for an explanation in so far as the subdivisions of this objective are not those commonly listed as Fundamental Processes. Cardinal Principles of Secondary Education refers to these processes as "reading, writing, arithmetical computations, and the elements of oral and written expression" (61:11). Interpreted in terms of the faculties trained, we have used instead the fundamentals of all education--the ability to observe, analyze, reason, judge, and express one's thoughts clearly. Any increase in these abilities will necessarily secure an increase in the facility of using the processes mentioned in Cardinal Principles of Secondary Education. For, though these abilities are not those referred to as "tools necessary for modern life", and though one might be able to read, write, cipher, and express one's thoughts by developing only one mental faculty--viz., the memory, to a high degree, it cannot be denied that development of such a type is not desirable as an equipment for life. Hence, the inclusion of such abilities as observation, analysis, reasoning, judgment, and

clear expression under the topic of Fundamental Processes seems justifiable.

The almost universally high percentage of affirmative answers shows that biology can, in the opinion of these consulted, stand the first test of educational worth required of a high-school subject--that it should have training or disciplinary value.

The order of importance of the various items is practically the same as that given by advocates of biology as a high-school subject:

(41:15; 40:128; 49:363).

The health objectives being accorded second place indicates that the practical value is, in general, given considerable consideration in our courses. Here again, the percentage of affirmative answers is unusually high. Several of the groups record 100% to certain of the items. While some of the groups give less than 60% to a few of the items, no one item receives less than 60% of total affirmative answers. Considering that the questions concerning this objective were numerous and that they called for an ability or adaptive control, the value of this objective as indicated by these answers is equal to, if it does not exceed, that of Fundamental Processes.

Benefits in regard to Ethical Character, or moral value, are placed third. We find here, also, that no item receives less than 60% of total affirmative answers. Although two groups give less than 60% to some of the items, no per cent is less than 50. Hence, there is sufficient evidence that the moral value of biology does exist and is being realized.

Fourth place is given to Worthy Home Membership. Under this objective have been placed certain items which, in the minds of some educators, would in themselves justify the incorporation of biology into the curriculum.

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these groups show a similar difference of interest in regard to bee-keeping. The interests covered by the first six or seven items are diversified enough to guarantee the relatively high cultural value of biology, while the items which create interest in special groups or individuals add to the richness of its culture.

Citizenship, with its seven items, gives much more varied results. The highest percentage of total affirmative answers is 95.3, the lowest, 25.8. The first three items receive a high percentage of affirmative answers--all over 89%; numbers four and five are rated about medium--62 and 57.5; while the last two (29.4 and 25.8) are so low as to indicate an absence of civic value as far as these items are concerned. Examining the content of the items more closely, we find that the broader and more general civic duties are realizable through the study of biology, but the more direct duties of taxpayer and voter are not. Nor, need we expect biology to fulfill this latter function. In doing so it would encroach upon the domain of another subject--civics--whose sole aim is the proper development of the citizen. By supplying a cultural background for civics, biology is rendering a considerable service to the cause of education in that by correlating the two subjects one can secure a degree of development impossible to civics alone.

The percentages of affirmative answers in regard to the choice of vocation are, in general, low. Although three of the six items receive over 60% of total affirmative answers, only in the first item are all the groups over 60%. Moreover the direct statement in regard to the influence of biology on the choice of vocation received only 24% of affirmative answers--the lowest recorded in the questionnaire. Hence, we can but conclude, that either biology has very little value as preparation for future work, or, which is more probable, its possibilities in this regard are as yet undeveloped.

VALUES GRAPHICALLY REPRESENTED

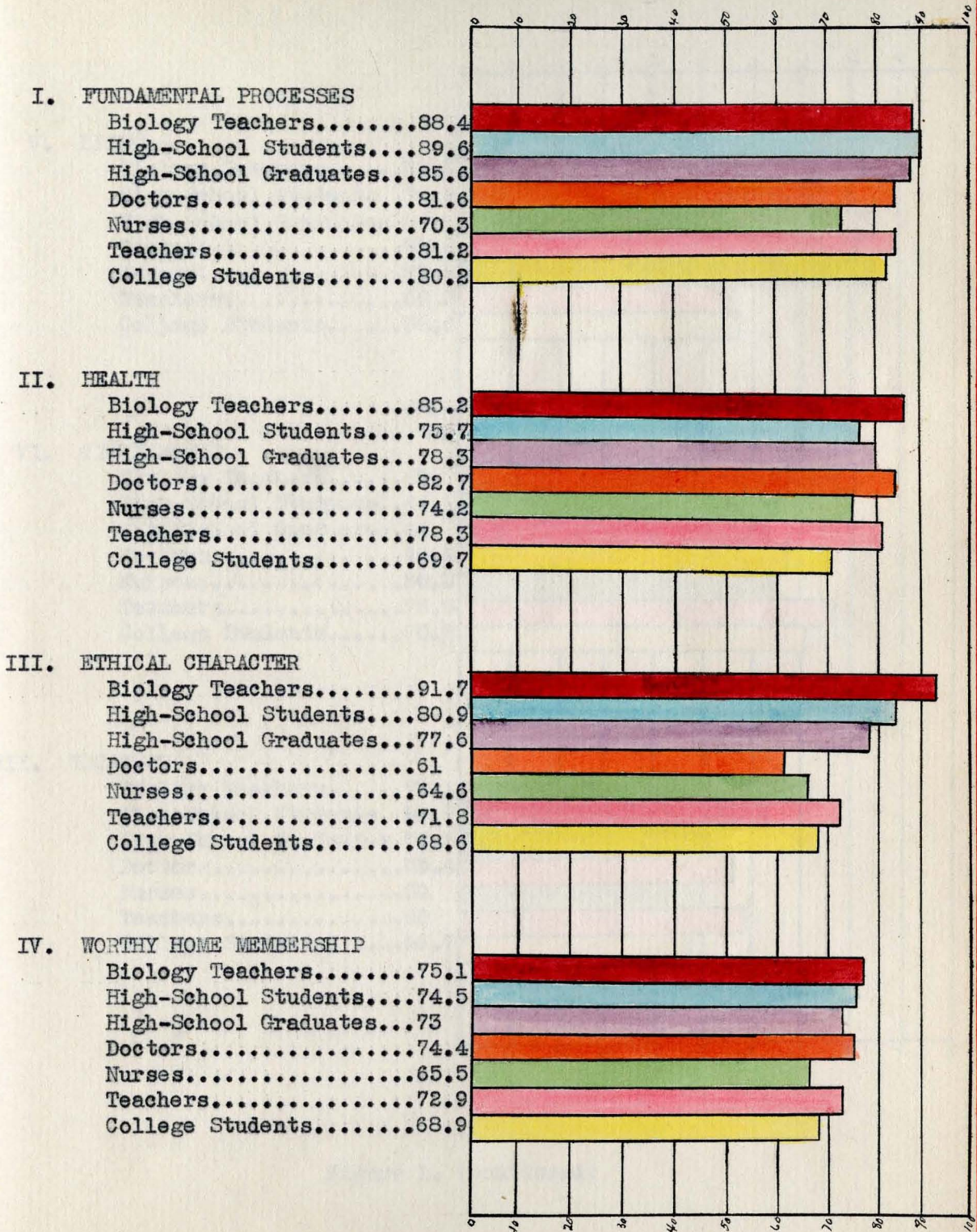
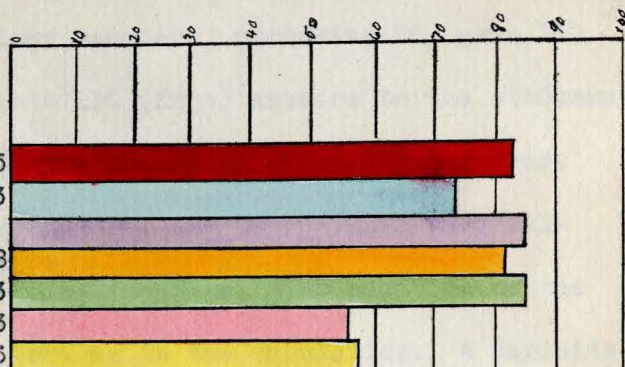


Figure 1.

V. LEISURE

Biology Teachers.....	82.5
High-School Students..	74.3
High-School Graduates..	86
Doctors.....	81.8
Nurses.....	85.3
Teachers.....	58.3
College Students.....	58.6



VI. CITIZENSHIP

Biology Teachers.....	81
High-School Students..	64.1
High-School Graduates..	64
Doctors.....	66.9
Nurses.....	66.3
Teachers.....	76.6
College Students.....	70.8



VII. VOCATION

Biology Teachers.....	72.1
High-School Students..	62.7
High-School Graduates..	52.3
Doctors.....	55.4
Nurses.....	50
Teachers.....	60
College Students.....	46.7



Figure 1. (Continued)

These results are more clearly presented in the bar graph of Figure 1. The bar represents the percentage of total affirmative answers given by each group to each objective. Thus, biology teachers, numbering 26, gave 115 affirmative answers out of the possible 130 (5x26) answers to the statements listed under Fundamental Processes. In terms of per cent these answers would be 88.4% of the total. In the same way the percentages were calculated for each group answering the questionnaire. The position of the objectives and of the groups is the same as in the tabulation. A definite color was assigned to each group in order to show the position given each objective by each group. Moreover, each combination of colored bars shows the percentage of affirmative answers given each objective by all those answering the questionnaire. This graph is merely a concise summary of the conclusions already drawn from the tabulation.

VALUES GRAPHICALLY REPRESENTED

I. BIOLOGY TEACHERS

Ethical Character.....	91.9
Fundamental Processes..	88.2
Health.....	85.2
Leisure.....	82.5
Citizenship.....	81
Home Membership.....	75.1
Vocation.....	72.1

II. HIGH-SCHOOL STUDENTS

Fundamental Processes..	89.6
Ethical Character.....	80.6
Health.....	75.7
Home Membership.....	75.1
Leisure.....	74.3
Citizenship.....	64.1
Vocation.....	62.7

III. HIGH-SCHOOL GRADUATES

Leisure.....	86
Fundamental Processes..	85.6
Health.....	78.3
Ethical Character.....	77.6
Home Membership.....	73
Citizenship.....	64
Vocation.....	62.3

IV. DOCTORS

Health.....	82.7
Leisure.....	81.8
Fundamental Processes..	81.6
Home Membership.....	74.7
Citizenship.....	66.6
Ethical Character.....	61
Vocation.....	55.4

Figure 28.

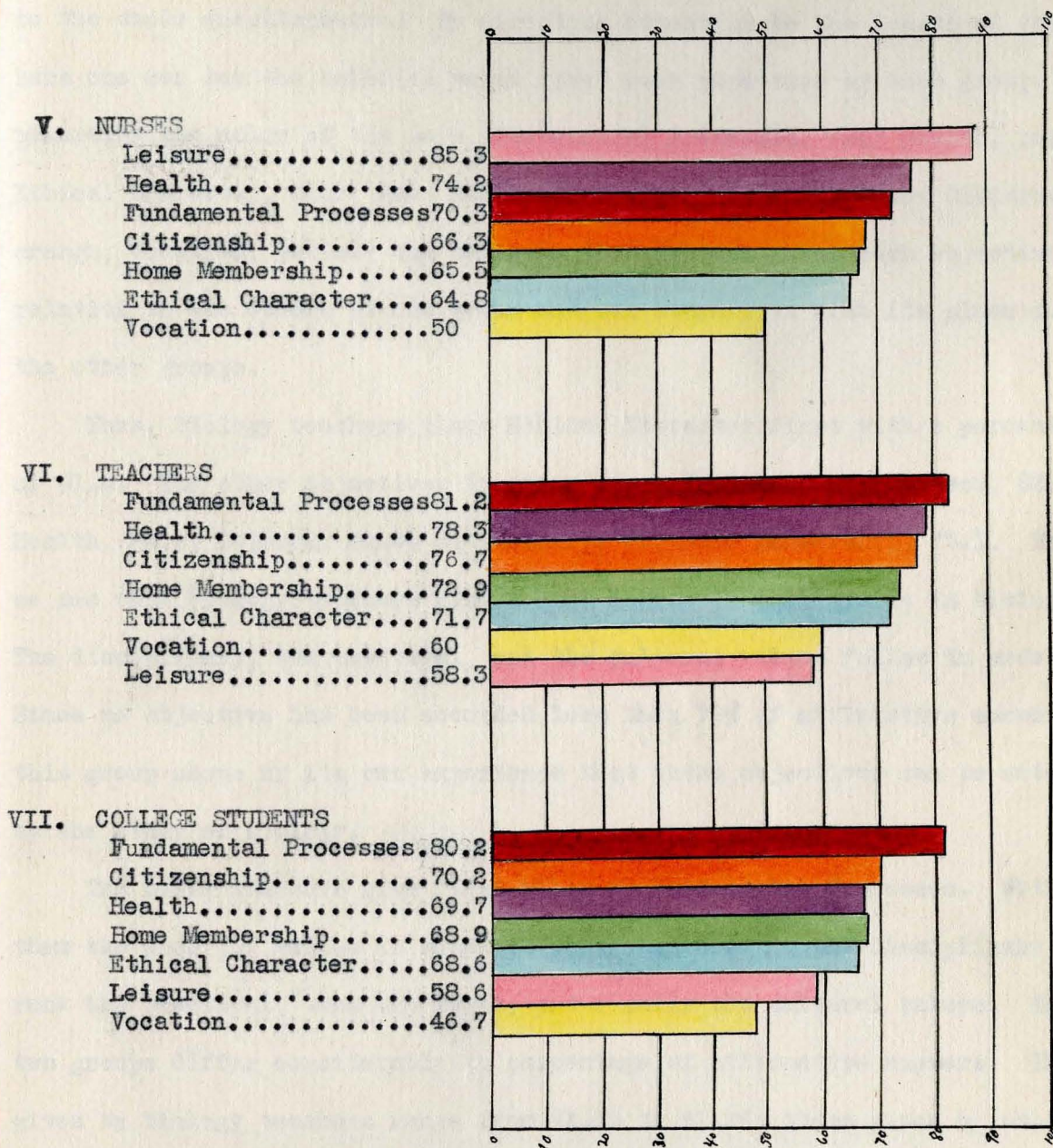


Figure 1. (Continued)

actual touch with its modern developments, and their lives are influenced by these changes. The other teachers place the disciplinary value first because the chief objective of biology, (botany and zoology), when most of these teachers studied the subject, was mental training. According to the ages given in the questionnaire more than 50% of the teachers were over 25 years old. Assuming that the average age at which they studied biology was 14, then, they studied biology more than eleven years ago, that is, during the period in which the greater number of biology courses still consisted of botany and zoology, and the chief objective was mental training.

Two other groups that show striking differences are the high-school students and the college students. The former show percentages of affirmative answers ranging from 62.7 to 89.6, while those of the latter range from 46.7 to 80.2. True, the groups vary widely in numbers, the high-school students being 60, the college students, 160. This cannot cause the difference, however, for the same tendencies are apparent in the college group in the first sixty papers examined as exist when the full tabulation is made. Nor can this difference be sufficiently well accounted for on the basis of age alone. Among the high-school students we find 68% who are 17 years or under, and among the college students we find 69% who are 21 years and younger. This leaves approximately four years difference in the average age of the groups. How may this difference affect the answers to the questionnaire? In the first place, although the biology courses are "not at all standardized", they are still staple enough that a space of four years cannot much affect the values that the two groups of students would find in the subject. But, the four years of mental training on the part of the college students should have developed reasoning and judgment to a high degree.

Hence their answers would be a more accurate index of values than those of the high-school students. Moreover, an average difference of four years in age means that it is at least five, and possible six or seven years since the college students studied biology in high school. This lapse of time has given them the opportunity to judge whether the values claimed for biology are permanent or not. Subject to this criteria their answers, in spite of the decrease in percentage, are sufficient to warrant the conclusion that these values are permanent, since only one objective, i.e., Vocation, is given less than 50% of affirmative answers.

A comparison of two other groups--doctors and nurses--shows a rather interesting parallel. Doctors give affirmative answers to the questionnaire ranging from 55.4% to 82.7%; Nurses from 50% to 85.3%. In regard to the order of objectives, doctors place Health first and Leisure second; nurses give Leisure first place and Health second. Then both groups agree on the order of the other objectives: viz., Fundamental Processes, Citizenship, Home Membership, Ethical Character, and Vocation. Curiously enough, these two groups, representing the professions for which biology has been claimed to be necessary as a direct preparation, assign the least value to the Vocation objective.

But this parallel is not at all surprising. By profession nurses and doctors have similar interests and view biology from the same standpoint. There is no evidence that a difference in age makes any difference in the answers. For while 62% of the nurses are under 25 years of age, only 12% of the doctors are under that age, and 57% are under 35 years of age.

The high school graduates form a group composed of individuals unclassified elsewhere. According to age, 50% of them are under 23, 72% are under

25 and only 5 are 30 years of age. According to occupation, 14 are doing various kinds of office work, 8 are clerks in different kinds of stores, 10 are housekeepers. The following occupations have one representative each: stage, sewing, photographer, surveyor, lawyer, and engineer. A few omitted to state their occupation. According to education 33 had had one-half to one year in college. Of the total, 14 are married and 9 have children.

Taken as a whole, the group represents just that class whose one year of high-school biology is all the scientific training of that character they ever get. They make up the great majority of graduates from high school who are at once face to face with the problems of "making a living and living a life". They form the class with whom it is most difficult to get in touch in a study of this kind. For, it should be noted, they are no longer in connection with any kind of an institution which can exercise its influence in favor of the importance of such information as they can give. In short, they are the persons for whom our high schools as institutions distinct from college preparatory schools develop their curricula. Hence their experience is of first importance to us.

This group ranks third in percentage of total affirmative answers. The objective given first place is Leisure, with a percentage of 86. Then follow in order Fundamental Processes, 85.6%; Health, 78.3%; Ethical Character, 77.6%; Home Membership, 74%; Citizenship, 64%; and lastly Vocation, 62.3%. Thus, we see that they found the cultural value of biology to be of first importance. The disciplinary value is given second place. Health which represents a very necessary practical value, is separated by the moral value from its companion objectives, Home Membership, Citizenship and

Vocation.

At first there may appear some duplication of the items of the questionnaire. For instance, No. 11 of the Health objective; "Biology increased my ability to make proper use of medicines," refers to the use of medicines as does also item No. 2 of Vocation; "Biology gave me valuable information in regard to medicines". The former indicates an increased ability, while the latter specifies valuable information. In other words, the distinction is that made by W.S.Monroe in his specific objectives. One is an ability or habit, that is, a fixed control; the other is information or knowledge, that is, an adaptive control. That the distinction was apparent to those who answered the questionnaire is proved by the difference in percentage of affirmative answers. While 70.3% testify to obtaining valuable knowledge only 61.7% assert that they possess an increased ability to make proper use of medicine. A similar discrepancy is evident, if we compare the answers of the groups, noting the single exception of the doctors who register 87.5% in regard to ability. However, that case explains itself. Doctors by their vocation have the opportunity of converting knowledge in regard to medicine into ability as to its proper use.

Then, No. 3 of Ethical Character says: "Biology increased my ability to co-operate with others". Here again we find an ability or fixed control clearly designated. Item No. 4 of Citizenship states: "Biology helped me to realize and to discharge my duties as a co-operator." While to realize one's duty is undoubtedly knowledge or an adaptive control, it may be argued that to discharge one's duties is an ability or a fixed control, hence similar to No. 3 quoted above. Granted that, there still remains the difference implied in the objectives. The ability to co-operate is an ethical or

moral virtue, wide in scope, while to discharge one's duties of co-operator as a citizen is merely an application of that ability. Though the difference in percentage of affirmative answers is not so marked as in the case mentioned above, there is sufficient difference to justify the conclusion that such a distinction was implied. While 68.1% gave affirmative answers in regard to increased ability to co-operate, 62% signified having been helped to realize and discharge their duties as co-operator.

In Ethical Character item No. 2 reads: "Biology showed me where and how to find occupation for my leisure hours." Such a statement might appear to include all the items listed under Worthy Use of Leisure. However, the ten sub-divisions of this objective cover a wide scope of interests whose development would contribute largely to the cultural values of biology, that is, would be included in W. S. Monroe's "generalized controls". Item No. 2 of Ethical Character contains both knowledge and ability, that is, both fixed and adaptive controls and hence varies materially from the objective which it seems to supersede. The difference in percentages of total affirmative answers is not so marked as in the preceding cases, No. 2 having a total of 70.2% and the objective, a total of 78.2%.

Again, item No. 7 of Worthy Use of Leisure, "As regards hunting and fishing biology resulted in an increase of interest," might be considered in part a duplication of item No. 1. of Vocation. "Biology gave me valuable general information in regard to forests and fisheries." The distinction here also may be expressed in terms of controls, that is, an increase of interest in hunting and fishing as an occupation for leisure time is a generalized control, while valuable knowledge in regard to forests and fisheries is an adaptive control. Moreover, in this case there is also a very marked

marked difference in percentage of affirmative answers, since No. 7 scores only 59.1% compared to 81.8% for item No. 1 of Vocation.

SUMMARY AND CONCLUSIONS

In answer to the questions proposed at the beginning of this chapter we may state:

1. It has been shown that the seven objectives of education can be and are being attained through the study of biology in our high school.
2. The relative value of these objectives, according to the writer's questionnaire, places them in the following order: Fundamental Processes, Health, Ethical Character, Worthy Home Membership, Leisure, Citizenship, Vocation.
3. The groups of individuals who have realized these objectives through the study of biology are the following: Biology teachers, high school students, high school graduates, doctors, nurses, teachers, and college students.
4. These seven groups cover such a variety of walks of life as to justify the conclusion that biology has been and is realizing very extensive educational values.
5. The results of the questionnaire show, furthermore, that certain fixed controls or abilities can be developed to a high degree by the study of this subject, and that generalized controls or ideals of a very desirable character can also be attained, and that knowledge or adaptive controls of a specific nature essential to modern life, though at present given a less prominent place, are possible of attainment.
6. The specific habits generated through the study of biology are the abilities listed under the objectives, Fundamental Processes and

answers to these objectives, we must conclude that biology has a high degree of value as a means of acquiring these specific habits.

7. Generalized controls or ideals are to be found under the objectives, Ethical Character, Citizenship, and Leisure. Of these objectives the first two mentioned have no record of affirmative answers less than 60% while the last, Leisure, has only one.
8. Knowledge or adaptive controls is the outcome of the remaining objectives, Home Membership and Vocation. Though the percentages of affirmative answers in regard to Vocation are not as high there is only one less than 50%. The answers to Home Membership, on the other hand, show none less than 60% and only two less than 70%. So that even here the subject has been proven rich in knowledge necessary as adaptive controls of conduct.

Thus we see that as far as the experience of those questioned can indicate, we have reliable evidence that biology can and does supply a necessary element in the training of that class of students which makes up the bulk of our high-school population. Its Leisure value is of inestimable worth to off-set the dangers of our present-day artificial amusements. Its Health value cannot be too strongly stressed as a preparation for the most successful living under the complicated conditions of modern life. Since with these values it combines the disciplinary and practical values so necessary in any subject, we can safely agree with the "Report of the Biology Teachers on Recommendations for a New Course of Study for the High Schools of Chicago", that is to say, what the Biology Teachers sought to prove theoretically, we have proved a

reality, in so far as the experience of the 445 persons interrogated may be considered to have substantiated the statement of these teachers.

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